NATIONAL ENERGY TECHNOLOGY LABORATORY

Cost Reduction and R&D Strategies for Advanced Oxyfuel Technologies

2010 NETL CO_2 Capture Technology Meeting

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Objectives

- **Guide R&D by Exploring Advanced Concepts in Oxyfuel (OF) Technology**
  1. ITM w/Optimized Heat Integration
  2. USC Steam Conditions (4,000psig/1,350°F/1,400°F)
  3. Co-Sequestration + Advanced Materials for Hi-S Recycle
  4. Advanced Shock Compression + Heat Integration
  5. Oxyfuel-Specific Boiler (+500°F, ↑ heat transfer, ↓ surface area 35%)

- **Assess Potential of Individual Technologies for Cost-Effectively Reducing Anthropogenic CO_2 Emissions from Power Plants**
  - ≥90% Carbon Capture
  - ≤30% Increase in Cost of Electricity over State of the Art (SOA) Air-fired PC Plant w/o Capture (Case 11 of NETL study below)
  - Link: http://www.netl.doe.gov/energy-analyses/pubs/Bituminous%20Baseline_Final%20Report.pdf

- **Evaluate the Benefits of Combining Multiple Advanced OF Technologies into One Plant**

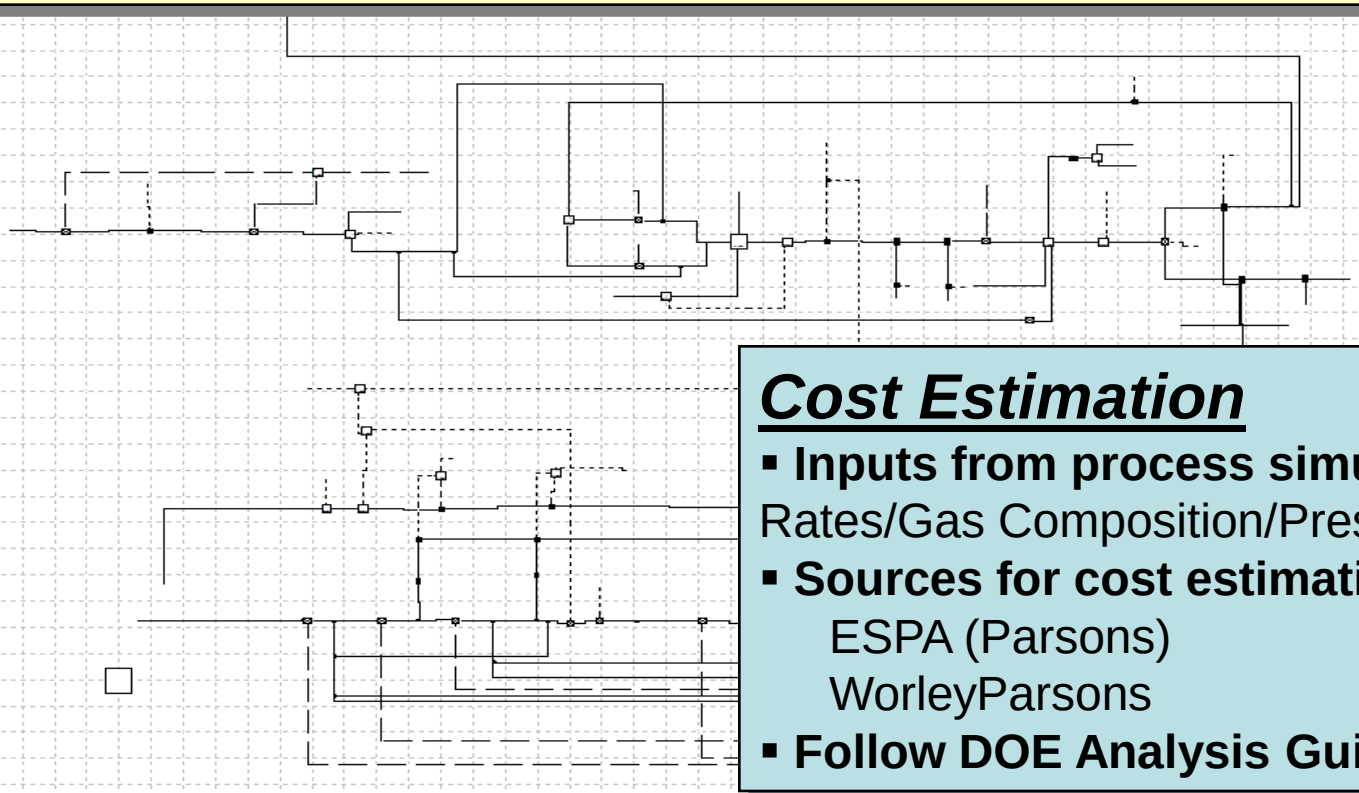
Executive Summary

- **Incorporating the five advanced technologies into one plant may boost SOA OF system efficiency by *over 10% points***
- **The cumulative savings in Cost of Electricity (COE) over a SOA OF system may be *~20% or ~$26/MWh.***
- **Cost of Avoided CO_2 may decrease by *58% or ~$29/ton.***
- **Cost of Electricity Increases by 30% over Base Air-Fired Case w/o Capture – *Pathway to NETL Goal!***

Systems Analyses

Engineering Studies and Extensive Process Simulation (ASPEN)

- All major processes and equipment based on vendor input
- Detailed mass and energy balances
- Performance calculations (auxiliary power, gross/net power output)



Cost Estimation

- **Inputs from process simulation** (Flow Rates/Gas Composition/Pressure Temp.)
- **Sources for cost estimation**
  - ESPA (Parsons)
  - WorleyParsons
- **Follow DOE Analysis Guidelines**

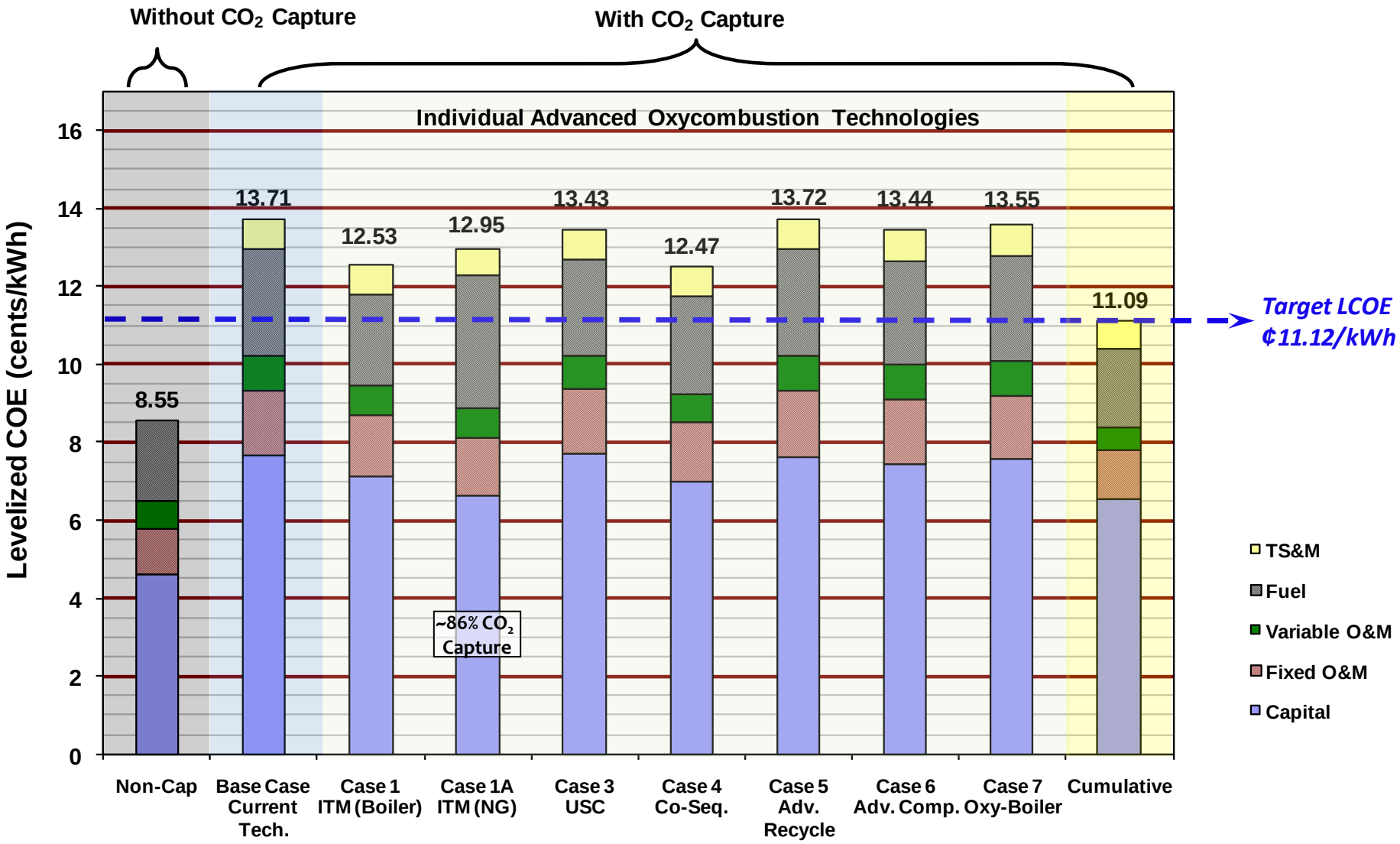
Study Outline

- **Performed seven techno-economic system studies to evaluate five advanced technologies**
  1. **Base Case (State of the Art Oxyfuel)**
  2. *ITM w/Optimized Heat Integration*
  3. *USC Steam Conditions*
  4. *Co-Sequestration + Advanced Materials for Hi-S Recycle*
  5. *Advanced Shock Compression*
  6. *Oxyfuel-Specific Boiler*
  7. **Cumulative Case (Incorporating technologies in 2-6)**

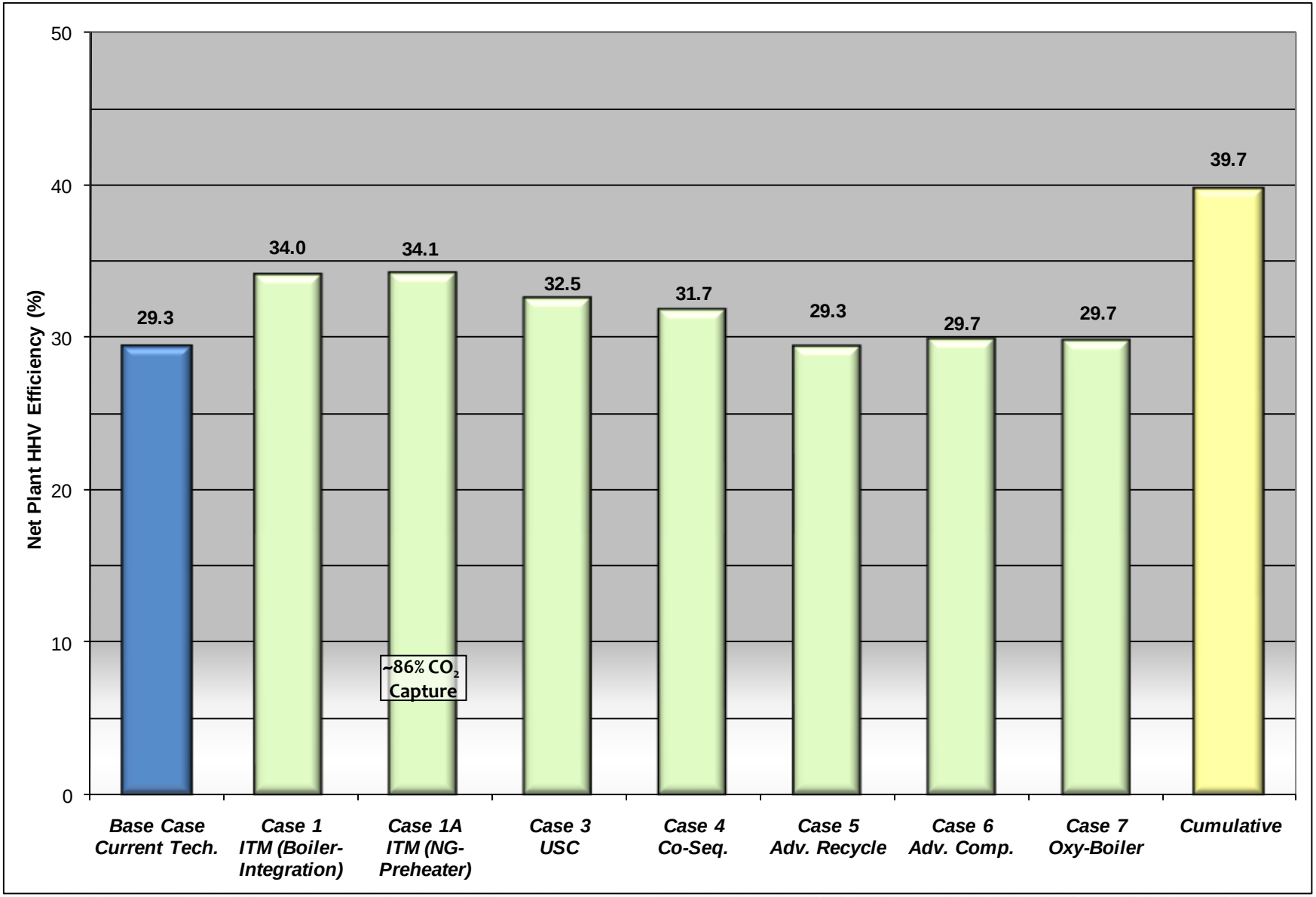
Capital and Operating Costs
Scaled from Previous Studies

Study Results

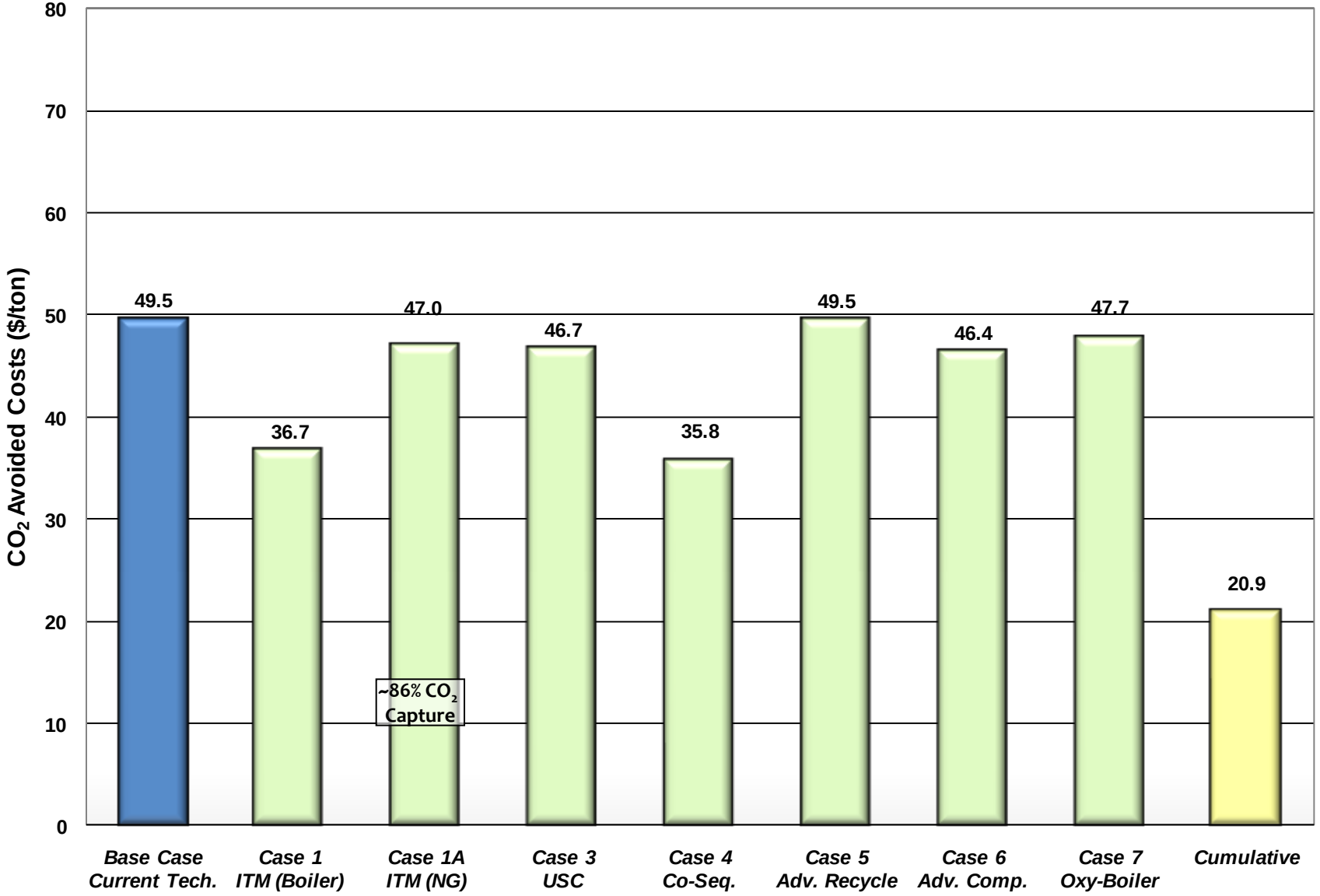
Plant LCOE Reductions



Plant Efficiency Improvements

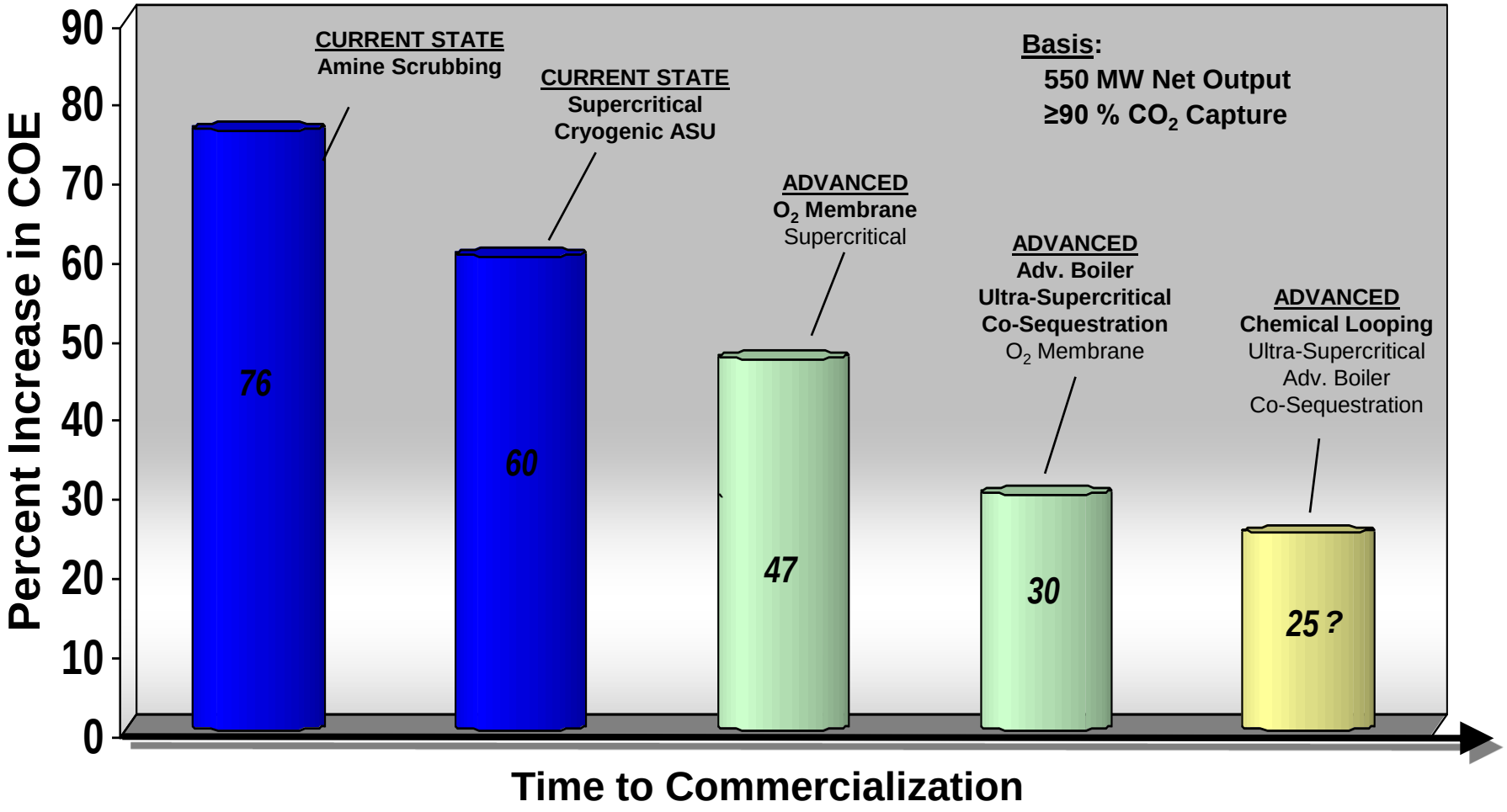


Cost of Avoided CO_2



Pathway to Meeting NETL Goals

Percent Increases in COE over SOA PC Plant w/o Capture



Reference: Advancing Oxycombustion Technology for Bituminous Coal Power Plants: An R&D Guide, NETL 2010

Conclusions

- **The five advanced technologies studied have great potential to pave the way to achieving NETL goals of 90% capture at ≤30% increase in cost of electricity**

- **Preliminary results show that with successful R&D, OF technologies can capture 90% CO_2 with ~30% increase in COE**

- **However, R&D success hinges on great strides in:**
  - Oxygen Supply: ITM system integration, performance and capital cost reduction.
  - Sulfur-Tolerant Materials: Sulfur-tolerant materials enabling co-sequestration.
  - Oxycombustion Boilers: Smaller, better performing oxycombustion-based boiler designs.
  - Advanced Steam Conditions: More aggressive Rankine cycles also increase performance of oxycombustion.

Ongoing Work

- **NETL is performing or funding research in all of these key areas. For more details, visit:**

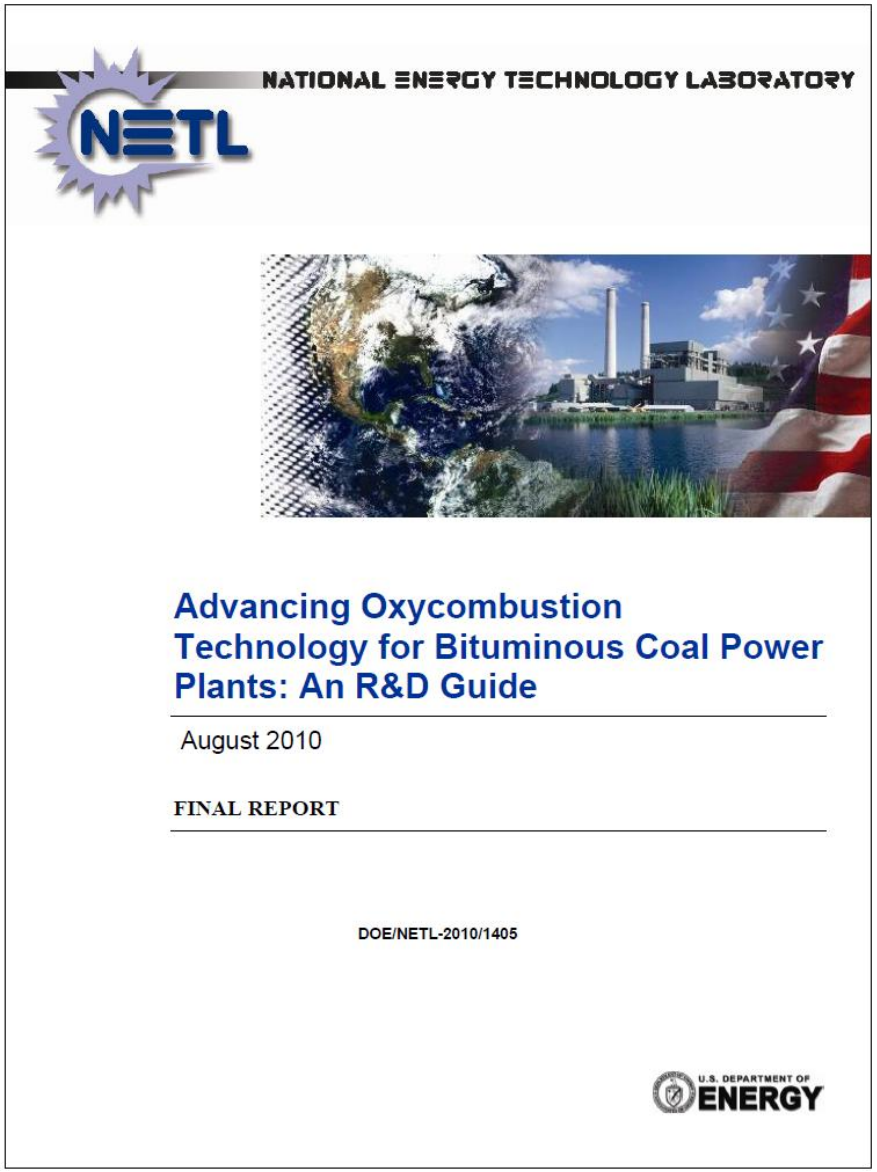
http://www.netl.doe.gov/technologies/coalpower/ewr/co2/OxyCombustion.html

Additional Information

Expected Posting:

October, 2010

www.netl.doe.gov



Any Questions?